

CLAIMS

What is claimed is:

1. An image segmentation method for use with an occupant, a sensor for generating sensor measurements, and an ambient image including an occupant and the area surrounding the occupant, said image segmentation method comprising the following steps:

receiving an ambient image represented by a plurality of pixels and a plurality of initial pixel values, wherein each said pixel has at least one said initial pixel value;

identifying one or more pixels as belonging to one of a plurality of pixel categories on the basis of one or more initial pixel values associated with the pixels being identified;

establishing a first revised pixel value for one or more pixels, wherein each pixel in the same pixel category has the same first revised pixel value;

setting a second revised pixel value for one or more of said pixels on the basis of one or more first revised pixel values that are associated with one or more pixels in the vicinity of the pixel being set; and

deriving a segmented image of the occupant from said first revised pixel value and said second revised pixel value.

2. An image segmentation method as in claim 1, wherein identifying one or more said pixels further includes generating an image threshold.

3. An image segmentation method as in claim 2, wherein identifying one or more said pixels further includes comparing said plurality of initial pixel values to said image threshold.

4. An image segmentation method as in claim 2, wherein generating an image threshold further comprises analyzing the distribution of initial pixel values relating to a pixel characteristic.

5. An image segmentation method as in claim 4, wherein analyzing the distribution of initial pixel values further includes:

recording aggregate initial pixel values into a histogram;
translating the histogram into a cumulative distribution function; and
calculating an image threshold based on a predetermined percentage of initial pixel values falling below the image threshold.

6. An image segmentation method as in claim 4, wherein each pixel has only one initial pixel value and only one pixel characteristic.

7. An image segmentation method as in claim 6, wherein luminosity is said pixel characteristic.

8. An image segmentation method as in claim 3, wherein each said pixel has a pixel location with respect to the ambient image, and said pixel location determines which of a plurality of image thresholds are compared to said initial pixel value for said pixel in said pixel location.

9. An image segmentation method as in claim 8, wherein a higher image threshold is applied in pixel locations where there is brighter lighting.

10. An image segmentation method as in claim 1, wherein there are only two pixel categories.

11. An image segmentation method as in claim 1, wherein setting the second revised pixel value includes a morphological heuristic.

12. An image segmentation method as in claim 11, wherein the morphological heuristic is a morphological erosion.

13. An image segmentation method as in claim 12, wherein the morphological heuristic is a morphological dilation.

14. An image segmentation method as in claim 1, wherein setting the second revised pixel value includes a momentum-based heuristic.

15. An image segmentation method as in claim 14, wherein a subset of said plurality of pixels are a group of adjacent pixels, wherein said plurality of pixel categories includes a first pixel category and a second pixel category, and wherein setting the second pixel value further comprises:

analyzing in a sequential manner the subset of pixels in the group of adjacent pixels;

adding to a counter value each time the next pixel in the sequence belongs to said first pixel category; and

subtracting from said counter value each time the next pixel in the sequence belongs to said second pixel category.

16. An image segmentation method as in claim 15, wherein the momentum-based heuristic stops when the counter value is less than or equal to zero.

17. An image segmentation method as in claim 1, wherein setting the second revised pixel value includes a gravity-based heuristic.

18. An image segmentation method for use with an occupant, a sensor for generating sensor measurements, and an ambient image of an occupant and the area surrounding the occupant, said image segmentation method comprising the following steps:

receiving an ambient image represented by a plurality of pixels and a plurality of pixel values, wherein each of said pixels has at least one said initial pixel value;

recording aggregate initial pixel values in a histogram;

translating the histogram into a cumulative distribution function;

calculating an image threshold using the cumulative distribution function with a predetermined percentage of initial pixel values falling below the image threshold;

categorizing each pixel in the plurality of pixels into one of a plurality of pixel categories by comparing the image threshold to the initial pixel value for the pixel being categorized;

establishing a first revised pixel value so that each pixel in the same pixel category shares the same first revised pixel value;

modifying said first revised pixel value into a second revised pixel value in accordance with morphological heuristic;

determining a third revised pixel value from said second revised pixel value or said first revised pixel value with a momentum-based heuristic;

identifying regions of pixels based on the first revised pixel value, the second revised pixel value, and the third revised pixel value;

generating a fourth revised pixel value from the regions of pixels in accordance with a gravity-based heuristic; and

deriving a segmented image of the occupant with the fourth revised pixel value.

19. An image segmentation method for use with an occupant as in claim 18, wherein deriving a segmented image of the occupant includes substituting the initial pixel value for said fourth revised pixel value representing the occupant image.

20. An image segmentation system for use with an occupant, a sensor for generating sensor measurements, and an ambient image of an occupant and the area around the occupant, said image segmentation system comprising:

an image thresholding subsystem, including a plurality of pixels representing the ambient image, and an image thresholding heuristic, said image thresholding subsystem categorizing said plurality of pixels in accordance with said image thresholding heuristic; and

a gap processing subsystem, including a gap processing heuristic, a subset of vicinity pixels in said plurality of pixels, and a plurality of pixel values, said gap processing subsystem selectively setting said pixel values in accordance with said gap processing heuristic and said pixel values belonging to said pixels in said subset of vicinity pixels; and

wherein a segmented image is generated from said plurality of pixels.

21. An image segmentation system as in claim 20, said image thresholding subsystem comprising a plurality of luminosity values, wherein each said pixel has at least one said luminosity value.

22. An image segmentation system as in claim 21, said image thresholding subsystem further comprising a histogram, wherein said histogram tabulates the number of said pixels having said luminosity value.

23. An image segmentation system as in claim 22, said image thresholding subsystem further comprising a cumulative distribution curve, wherein said histogram is converted into said cumulative distribution curve by said image thresholding subsystem.

24. An image segmentation system as in claim 23, said image thresholding subsystem further comprising a predetermined percentage and an image threshold, wherein said image threshold is calculated from said predetermined percentage and said cumulative distribution curve.

25. An image segmentation system as in claim 24, said image thresholding subsystem comprising a plurality of image thresholds and said pixel includes a pixel location, wherein said pixel location for said pixel determines which said image threshold is used for said pixel by said image thresholding subsystem.

26. An image segmentation system as in claim 24, said image thresholding subsystem further including a first subset of said plurality of pixels and a second subset of said plurality of pixels, said image thresholding subsystem dividing said plurality of pixels into said first subset of pixels and said second subset of pixels with said image threshold.

27. An image segmentation system as in claim 26, said image thresholding subsystem further including a first binary value and a second binary value, wherein said first subset of said plurality of pixels is set to said first binary value and said second subset of said plurality of pixels is set to said second binary value.
28. An image segmentation system as in claim 27 wherein at least approximately half of said plurality of said pixels are set to said first binary value.
29. An image segmentation system as in claim 20, said gap processing heuristic including a morphological heuristic.
30. An image segmentation system as in claim 29, said morphological heuristic comprising a morphological erosion.
31. An image segmentation system as in claim 29, said morphological heuristic comprising a morphological dilation.
32. An image segmentation system as in claim 29, said morphological heuristic comprising a vertically-based morphological heuristic.
33. An image segmentation system as in claim 29, said morphological heuristic comprising a horizontally-based morphological heuristic.
34. An image segmentation system as in claim 20, said gap processing heuristic comprising a momentum-based heuristic and said subset of vicinity pixels comprising a subset of sequential pixels, and said gap processing subsystem selectively setting said pixel value using said momentum-based heuristic and said pixel values relating to said subset of sequential pixels.
35. An image segmentation system as in claim 34, said sequential subset of pixels including a sequential vertical subset of pixels and a sequential horizontal subset of pixels, wherein said momentum-based heuristic analyzes said pixel values in said

sequential vertical subset of pixels and said sequential horizontal subset of pixels, to determine said plurality of pixel values.

36. An image segmentation system as in claim 35, said momentum-based heuristic further comprising a momentum counter, said momentum counter determining when said gap processing subsystem terminates said momentum-based heuristic for said pixel value.

37. An image segmentation system as in claim 27:
said gap filling heuristic comprising a gravity-based heuristic, a pixel region, and a region characteristic;
said plurality of pixels including a target pixel;
wherein said pixel region includes one or more said pixels;
wherein said pixel region does not include said target pixel; and
wherein said pixel region is a subset of said vicinity pixels.

38. An image segmentation system as in claim 37:
said gravity-based heuristic further including a region size and a region distance;
wherein said region size is the number of said pixels in said pixel region;
wherein said region distance is the distance between said target pixel and a center point in said pixel region; and
wherein said gap processing subsystem sets said target pixel in accordance with said region size, said region distance, and said gravity-based heuristic.